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A REPORT
on
Zur Dam

Prepared by
Project Treasure Island
for
Directorate of Intelligence, USAF
1954

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Z U R D A M (P O L A N D)

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This report contains information requested on the Zur (Szur) Dam on the Czarna Woda (Wda) River in Poland, which serves for the production of power as a peak-load hydroelectric power plant. The report is based on a study of Polish open sources, published between 1921 and 1938, and listed in the attached bibliography. The most valuable material was found in sources listed under Nos. 4, 7 and 15.

The present information is compiled in accordance with the P.V.D. questionnaire as follows:

I. Functions

A. The system of which the dam forms a part

With respect to power production, the Zur Dam with its powerhouse forms a part of the interconnected power system supplying energy to the Wojewodztwo Bydgoskie (Province Bydgoszcz), known as the "Pomorska Elektrownia Krajowa 'GRODEK', S. A. w Toruniu" (Regional Pomeranian Electric Power Plant "Grodek" Inc. in Torun). The development of this system as it existed in 1936 and as it was planned for the future, is shown on map Fig. 1.

B. The dam within the system

The Czarna Woda River (also called Wda), on which the dam is built, is not navigable. It is used only occasionally for the floating of timber. The Zur Dam is the first

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upstream dam on the Wda River. It is followed 7 km downstream by the Grodek Dam. The purpose of the Zur Dam is to obtain a sufficient storage to satisfy the peak-load demand for electric power.

C. Highways and railways resting on the dam or adjacent thereto

No highway or railroad rests on the dam. Two concrete bridges for purely local use span the diversion canal.

A highway about 1.5 km below the dam runs to Gdansk (Danzig) and Drzycim (local R. R. Station) with a branch to Laskowice (R. R. Station for the Grodek Plant) (Fig. 2).

D. Navigation locks in connection with the dam

No navigation locks were built.

II. Location and designation

A. Data which will make possible pinpointing the installation

The Zur Dam is located on the Czarna Woda (Wda) River, which is a left bank tributary of the Wisla (Vistula) River. Zur belongs to the Wojewodztwo (province) Bydgoskie, Powiat (county) Swiecie (Fig. 1).

B. Official, local and popular names of dams and dependent installations

Szur, Zur.

III. Dimensions

A. Dam

1. Maximum and minimum head on dam

Maximum head on powerhouse is 15.5 m gross and 15.2 m net (Elevation 67.5 m to 52 m).

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Normal head (average) is 14.8 m.

2. Maximum and minimum depth of water below dam

It is a diversion dam with a small flood discharge into the downstream river bed.

3. Total height of dam above river bed and above foundations

See Fig. 3.

4. Elevation of bottom of penstocks at dam

There are no penstocks in the dam except for a discharge sluice (see Chapter VI - D).

5. Total thickness at base and at high water level

See Fig. 3.

6. Slopes of dam faces

See Fig. 3.

7. Length at crown, across river bed, and along spillway

See Fig. 3.

This dam has no spillway.

B. Reservoir

See Figs. 4, 5 and 6.

1. Capacity

14,200,000 cu m. Daily fluctuations of about 0.3 m give an effective capacity of 1,500,000 cu m.

2. Area

500 ha.

3. Length, width and depth (including profiles)

16 km long. The maximum depth at the dam is 14.5 m.

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4. Detailed plan in the vicinity of the dam

The banks of the reservoir are wooded. (Puszcza Tucholska-Puszcza-Forest). An 850-m diversion canal leads to the powerhouse penstocks. A bird's-eye view of the reservoir and dam is presented in Figs. 4 and 5.

C. Navigation locks in connection with dams (structural details)

No navigation locks were built in this dam.

IV. Hydrological data (rainfall, flow, etc.)

General data about the region (Pomerania)

The average annual rainfall in Pomerania is 550 mm.

The average runoff per sq km for Pomeranian rivers is between 3.1 and 8.2 liters/sec.

The average incline of the Pomeranian rivers is 0.5 to 1.5 o/oo.

The lakes of Pomerania form natural reservoirs and contribute to the regularity of the flow.

Data about Czarna Woda (Wda) River

The average annual rainfall for the catchment area of the Czarna Woda River is 549 mm.

The average runoff per sq km is 8.6 liters/sec.

Maximum runoff is 21.9 liters/sec.

Minimum runoff is 3.0 liters/sec.

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The catchment area of the river is 2,202 sq km.

The total length of the river is about 186 km.

The Czarna Woda River starts 49 km from the Lake Wdzydze which lies at an elevation of 133 m.

The Zur Dam is located 149 km from the source of the Czarna Woda River and lies at an elevation of 52 m.

The catchment area upstream from Zur is 1,720 sq km.

At its confluence with the Vistula River, the Czarna Woda River reaches an elevation of 22.5 m. Thus the total difference in the levels of the utilizable section of the Czarna Woda River from Lake Wdzydze to its confluence with the Vistula River is 110.5 m.

The average flow of the Czarna Woda River at Zur is 14.8 cu m/sec.

Maximum (flood) flow is 50 cu m/sec.

V. Foundation conditions and soil characteristics under and near the dam

Borings about 20 m deep at the site of the dam disclosed alternating alluvial layers of clean, fine sand and some with admixtures of loam, and of coarse sand with small stones. On the right side of the dam site is a layer of gray loam. The excavation for the foundations of the dam was made according to the conditions of the soil, 1 to 3 m deep, in order to reach firmly settled layers of loam or sand.

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VI. Design data

A. Structural type or types

The dam is an embankment dam of the non-overflow type, provided with a Larssen steel sheet piling curtain and a concrete core wall. It was built in 30-cm thick layers of marly clay and rolled by two caterpillar tractors with a pressure of about 2 kg/sq cm. There is a concrete foundation under the whole length and width of the dam (Fig. 3).

B. Materials used

The dam is built with material obtained from digging the diversion canal. It consists in 80 per cent of marly clay with an admixture of small and large stones contained in the 3 to 12 m thick layers of fundamental moraine which form the canal bed. The material obtained from the deeper, not weathered layers is of gray color and contains up to 8 per cent of calcium carbonate. The weathered soil is yellow and contains only about 3 per cent of calcium carbonate.

The whole upstream face of the dam is covered with sand. It is lined with hand placed rip-rap reaching 1 m above normal water level and 2 m below it.

The whole downstream face of the dam is covered with sandy loam and topsoil fortified by bushes and sed. The dam has a toe of rocks 50 to 80 cm in diameter on the downstream side.

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C. Design criteria

No information available.

D. Details and equipment (penstock, control gates, inspection galleries, cranes, etc.)

1. Diversion canal (Figs. 2, 6 and 7)

The canal is 850 m long, with a trapezoidal cross-section.

The side slopes are 1: 2 and the incline 0.2 o/oo.

The wetted cross-section area is 51.2 sq m. The canal is lined with concrete. The canal inlet can

be closed by emergency stop-logs, operated by hand.

The canal is built for a flow of 72.0 cu m/sec

although the flood flow is 50 cu m/sec. The water velocity is 1.4 m/sec.

2. Discharge sluice (Fig. 3)

It consists of two twin tubes 110 m long. The cross-

section area of both tubes is 8 sq m. They are made of reinforced concrete and placed at the bottom of

the dam. They are used as emergency flood outlets.

Each tube is closed by two gates, placed in series

and each built to withstand the full pressure of water.

The gates are electrically operated from a gatehouse placed atop the dam.

The kinetic energy of the discharged water is absorbed by baffles.

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3. Log chute (Fig. 2)

A log chute connects the lower part of the diversion canal with the tailwater close to the powerhouse. It also serves for the discharge of ice.

4. Penstocks, cranes

There are neither penstocks nor cranes at the dam.

VII. Special data on power damsA. Capacity (kva), present and proposedInstalled

8,800 kva (8,200kw). (1938). No further development was proposed.

B. Output (kw hr/yr) achieved and proposed

Output achieved in 1937 was 13,446,000 kwhr.

The maximum possible output was estimated at 14,500,000 kwhr with the annual hour utilization number of 1,800.

C. Powerhouse1. Location (Figs. 2 and 5)

About 800 m downstream (east) from the dam, at the end of the diversion canal.

2. Structure (Figs. 8, 9, 10, 11, 12 and 13)

The powerhouse is of reinforced concrete, erected on a foundation consisting of a 7 m deep, tight Larssen steel-sheet cut-off wall filled with reinforced concrete.

The powerhouse is 27 m high (including the foundations), 31 m long and 12.5 m wide.

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3. Installations (Turbogenerators, etc.) (Figs. 12 and 13)

The powerhouse is equipped with two vertical, 6,000-hp, 250-rpm, Kaplan turbines, coupled with two vertical 4,400-kva, 6-kv generators. The average net head is 14.8 m. The control room with switchboards is in the north wing of the powerhouse. A working bay is at the south wing of the powerhouse. The 6-kv switchgear equipment is located in the west part of the powerhouse.

A 25-ton traveling crane with a 10-m span is located in the powerhouse above the turbines.

4. Number, dimensions, location and type of penstocks

The penstocks (Fig. 14) are located at the end of the diversion canal and start from the gatehouse (Figs. 2, 5 and 8). The gatehouse is a structure of reinforced concrete, built on a reinforced concrete foundation surrounded by 5-m deep steel-sheet Larssen cut-off walls (Figs. 8, 15 and 16). The penstock consists of two reinforced concrete pipelines, 50 m long, with an inside diameter of 4 m and a wall thickness of 22 cm. The pipelines are reinforced with iron rings, electrically welded at the site. The water flow through each pipeline is 37.5 cu m/sec. The pressure inside the pipelines is 1.2 atm. To protect pipes from freezing, the top of the penstocks is covered with a 1.2 m layer of earth. The intake of the penstocks is protected by an electrically heated

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rack, which melts the ice. There are two sliding gates consisting each of two parts (upper and lower).

D. Places of installations served; ties with power grids

Zur belongs to the "Grodek" electric power system (Fig. 1) as a peak-load plant. A 60-kv transmission line connects the Grodek and Zur Power Plants with the seaport of Gdynia. The network supplies electric power to Gdynia for industrial and public utility consumption and to several towns in Pomerania, mostly for public utility consumption.

E. Location and description of transformer yards and transmission system

The outdoor step-up 6/60-kv transformer yard is located some 50 m south from the powerhouse (Figs. 2, 5, 17 and 18). It occupies a 60 x 90 m area. It is equipped with two 6/60-kv, 5,500-kva oil transformers; two 60-kv oil circuit breakers for transformers and oil circuit breakers for the four outgoing 60-kv transmission lines, planned in 1930 (to Grodek, Tlen, Gdynia and Grodek) (Fig. 17). The remaining equipment consists of disconnecting switches, instrument transformers and busbars. The oil-cooling installation is located next to the main step-up transformers.

VIII. Historical data

A. Name and background of the designer

All designs and plans for the construction of the dam and powerhouse were prepared by the engineering bureau of the

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"Pomorska Elektrownia Krajowa 'Groddek' S. A. w Toruniu."

B. Dates of construction

Work on the dam started in the fall of 1928. The diversion canal was filled on December 18, 1929 and the test run of the turbines was made on December 20th 1929.

The regular operation of the power station started on February 15, 1930.

C. Sources of material

Earth (clay) excavated from the diversion canal was used for the dam. Cement, iron, Larssen cut-off piling, stone and sand, were obtained from local sources.

The turbines came from the firm Voith, St. Poelten, Austria.

The generators, big transformers and most of the high-voltage equipment came from the firm "Asea," Vasteras, Sweden.

The remaining equipment: cables, electric motors, installation material, measuring instruments, etc. came from Polish firms.

D. Records of war damage, failures, removal of equipment etc.

No information available.

E. Data on conditions of structure at any date

The latest information available is from 1937-1938.

F. Proposals for enlargement, alteration or extension of function

No further expansion is planned since the total power resources of the river are already utilized by the Grodek and Zur Power Plants.

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IX. Graphic material

A. Photographs

Figs. 6, 7, 9, 10, 11, 14, 16 and 18.

B. Working drawings, general and detailed

None available.

C. Record and publication drawings

Figs. 1, 2, 3, 4, 5, 8, 12, 13, 15 and 17.

D. Sketches by persons who have seen installations

None available.

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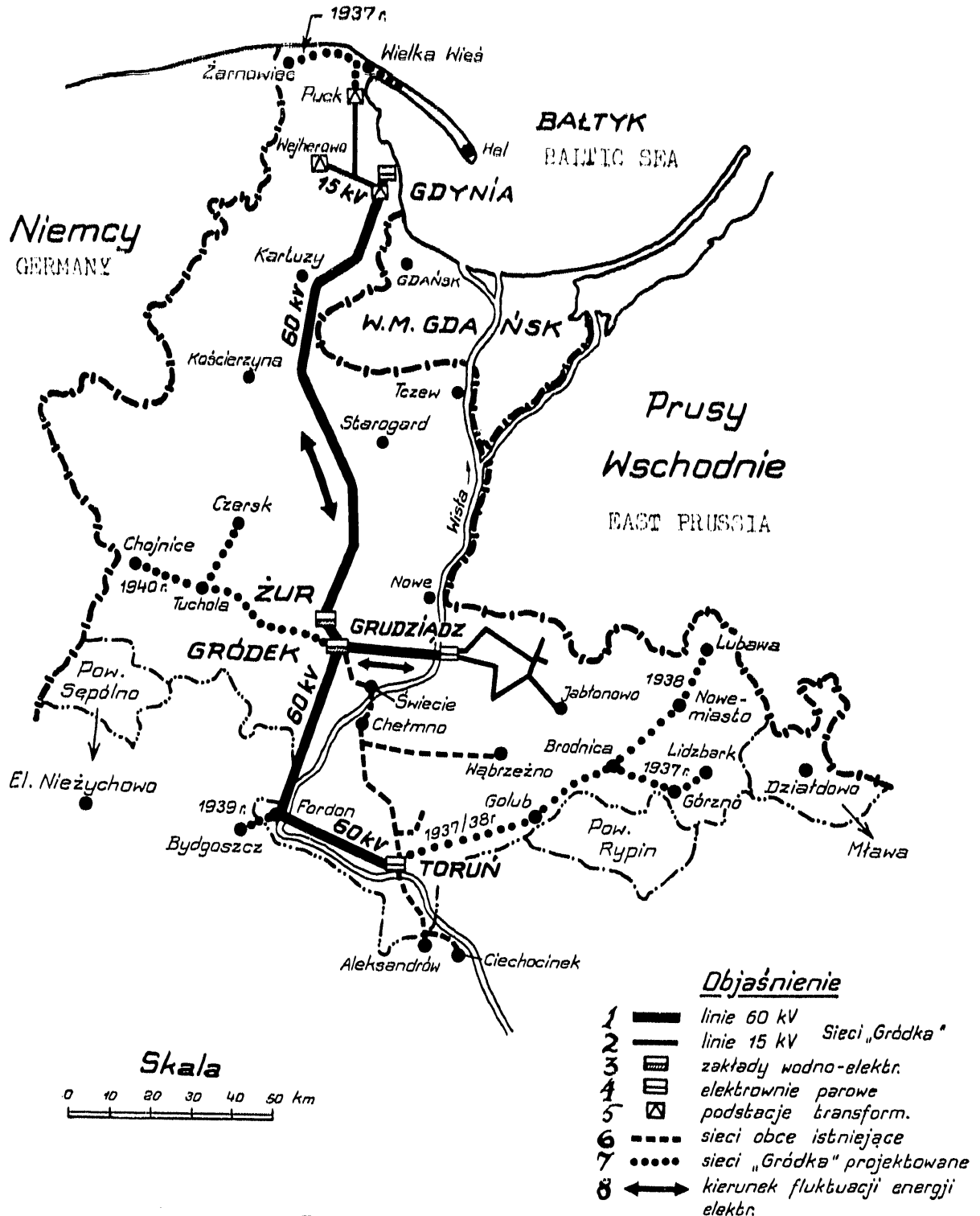
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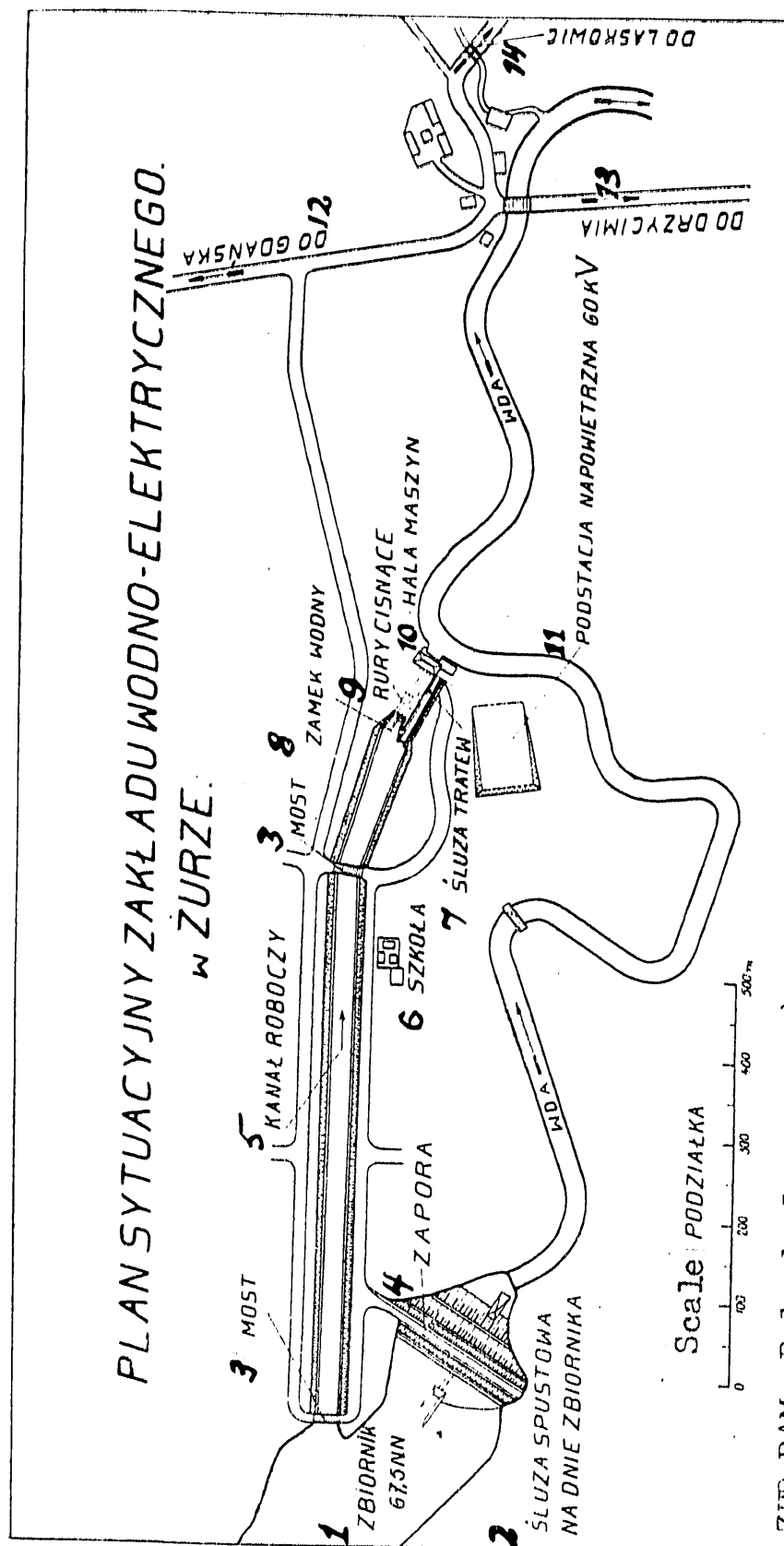
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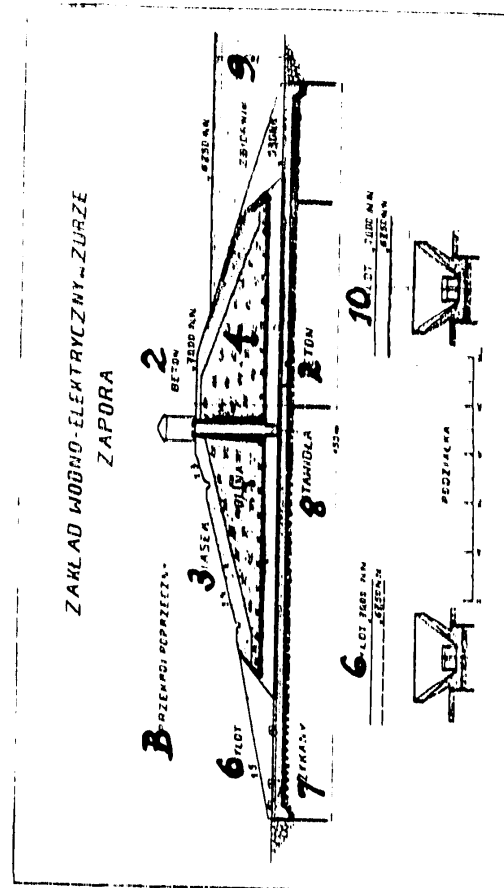
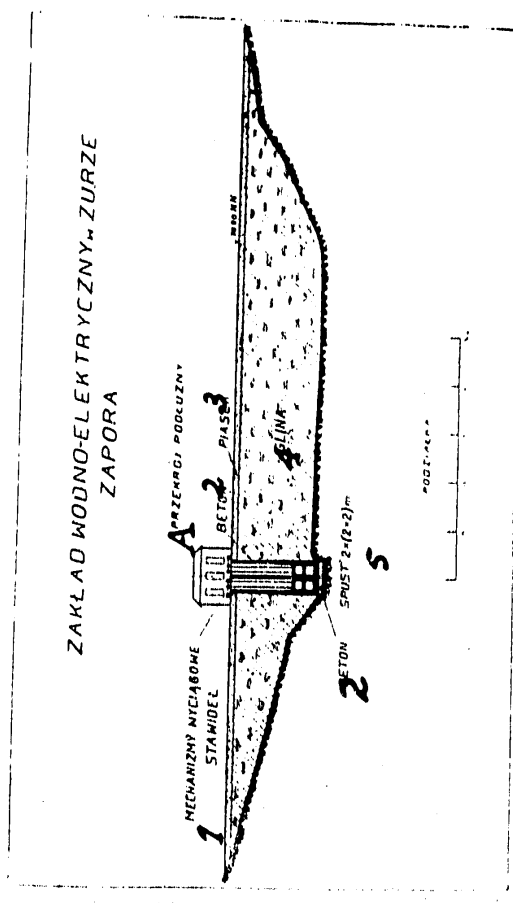


ZUR DAM, Poland. Transmission Network of the "Gródek System". 1) 60-kv Gródek transmission lines 2) 15-kv Gródek transmission lines 3) Hydro power plants 4) Steam power plants 5) Transformer substations 6) Other adjoining transmission lines 7) Proposed extension of Gródek network 8) Interchange of electric power.

Source: Przegląd Elektrotechniczny, Warsaw, 1936, No. 23, Dec.1, p.788



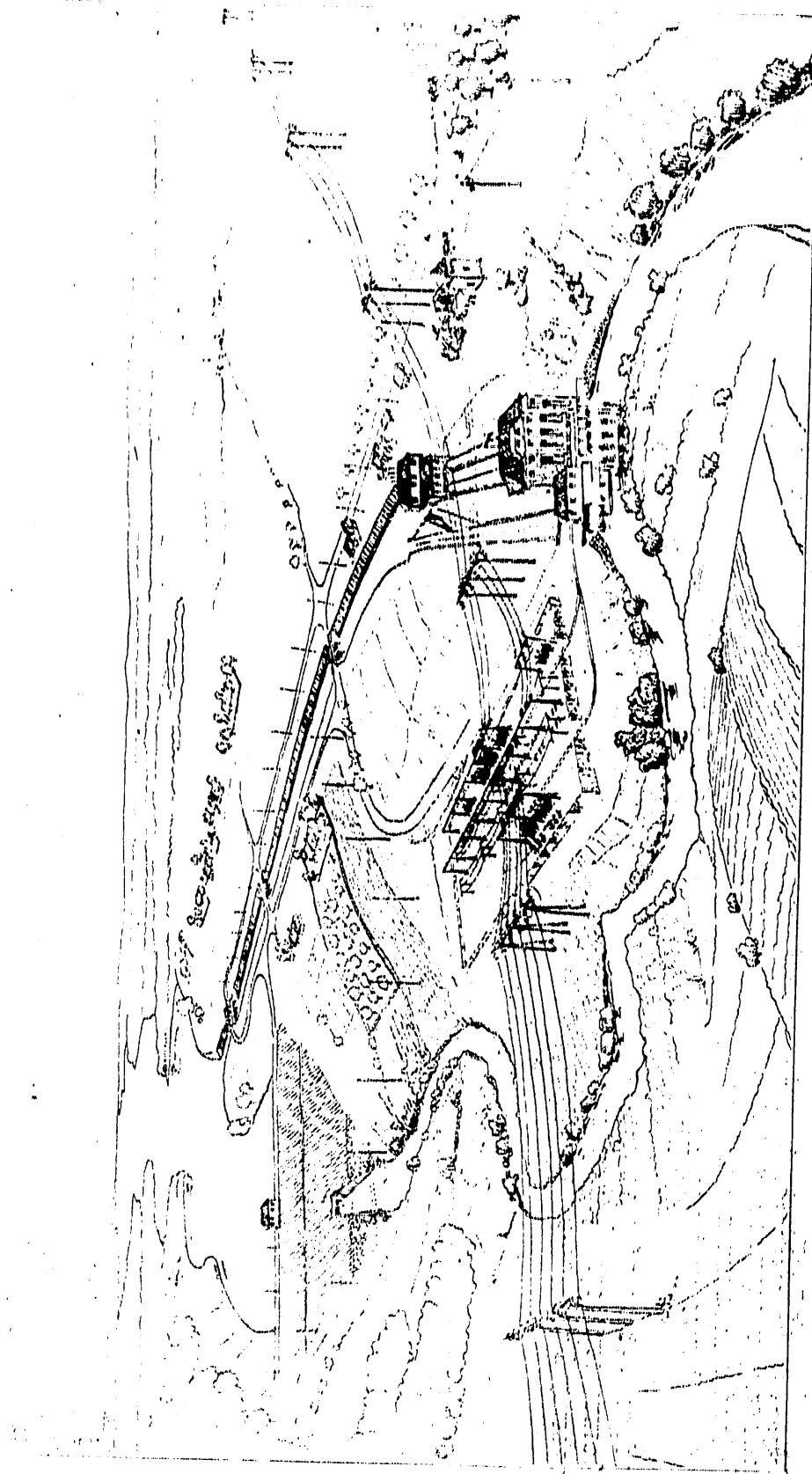
ZUR DAM, Poland. Layout. 1) Reservoir 2) Sluice outlet 3) Bridge 4) Dam
5) Diversion Canal 6) School 7) Log chute 8) Gate house 9) Penstocks 10)
Powerhouse 11) Transformer yard 12) Highway to Gdansk 13) - to Drzycim 14)
- to Laskowice R.R. Station . Source: Przegląd Elektrotechniczny, Warsaw,
1930, No. 4, p. 79



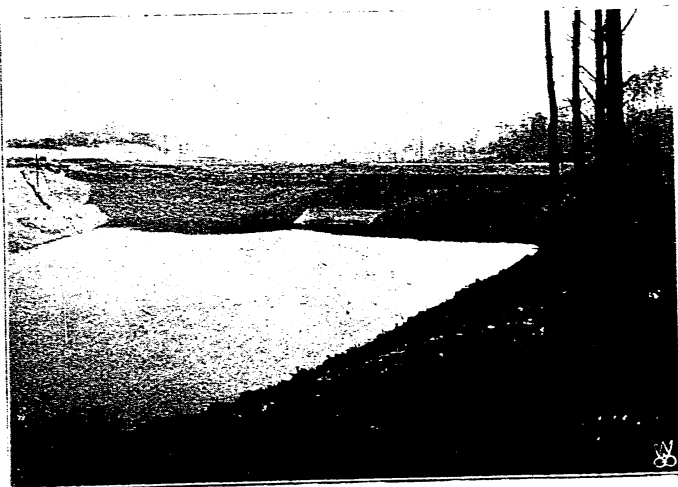
ZUR DAM, Poland. A) Longitudinal Section 1) Sluice gate house 2) Concrete 3) Sand 4) Clay 5) Sluice opening B) Cross Section 6) Sluice outlet 7) Baffles 8) Sliding gates 9) Reservoir 10) Sluice intake . Source: Przegląd Elektrotechniczny, Warsaw, 1930, No. 4, p. 79



ZUR DAM, Poland. Reservoir. Source: Przegląd Elek+rotechniczny, Warsaw, 1930, p.73



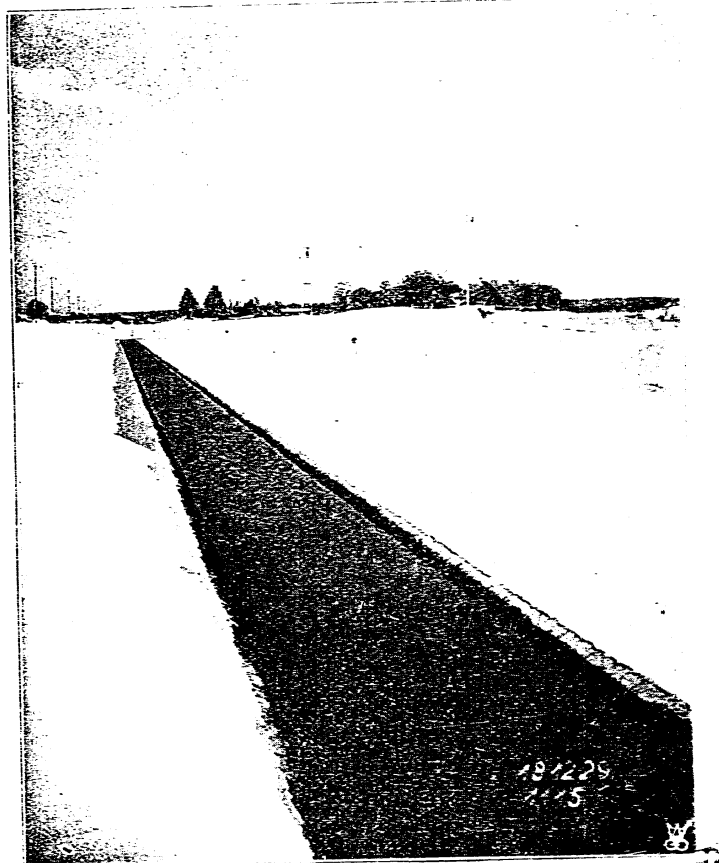
ZUR DAM, Poland. Powerhouse and Transformer Yard. Source: Przegląd Elektro-techniczny, Warsaw, 1930, p. 74

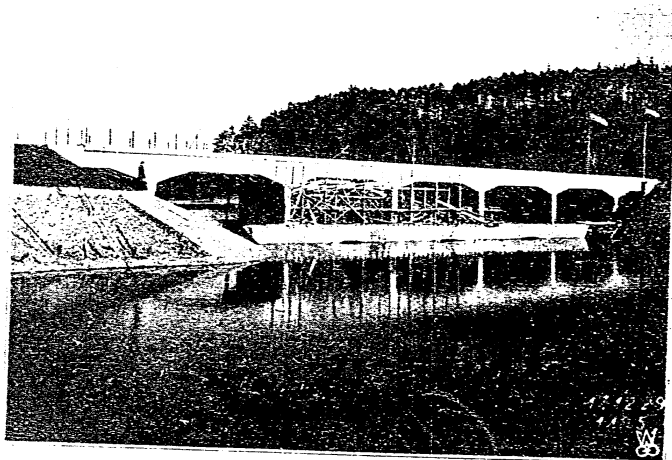


Above: The Dam and the Reservoir.

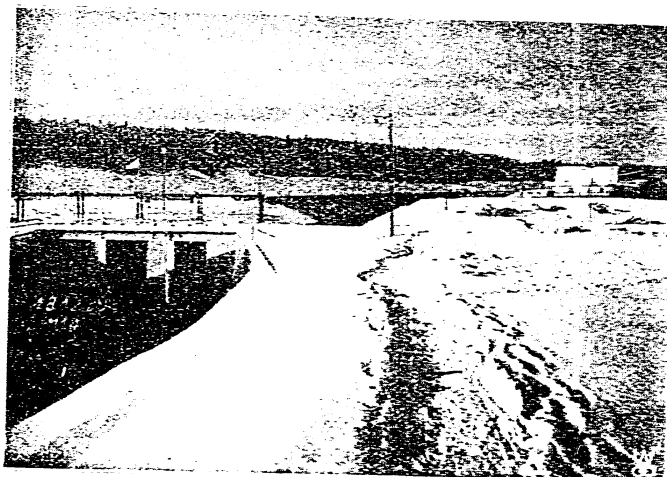
Right: Diversion Canal.

ZUR DAM, Poland. Source: Przegląd Elektrotechniczny, Warsaw, 1930, p. 80

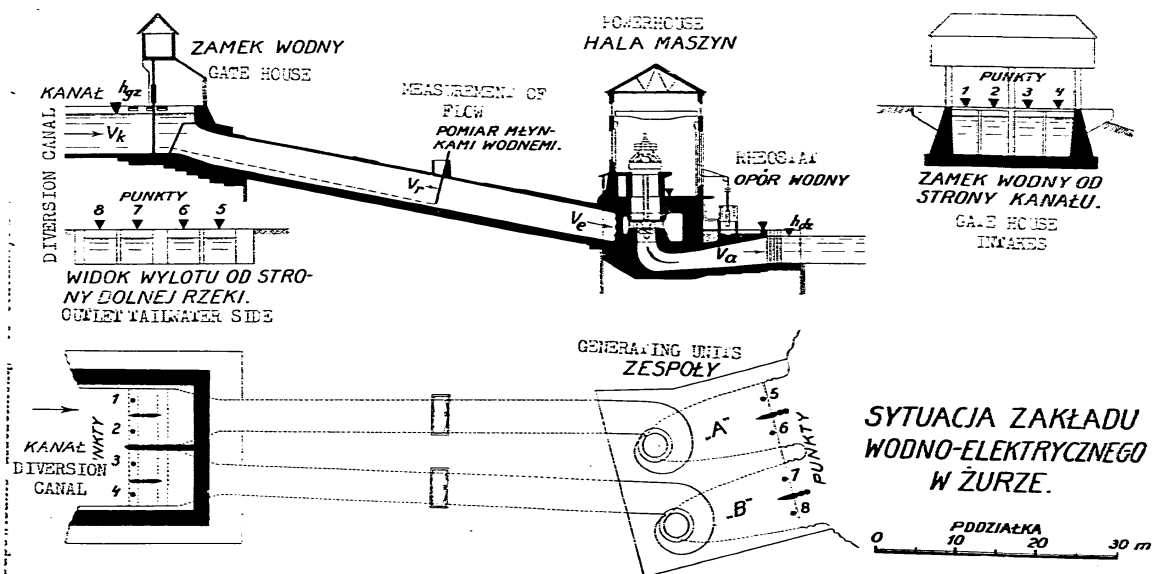




Bridge in Tleń,
ZUR DAM, Poland. Source: Przegląd Elektrotechniczny, Warsaw, 1930, No. 4, p. 20

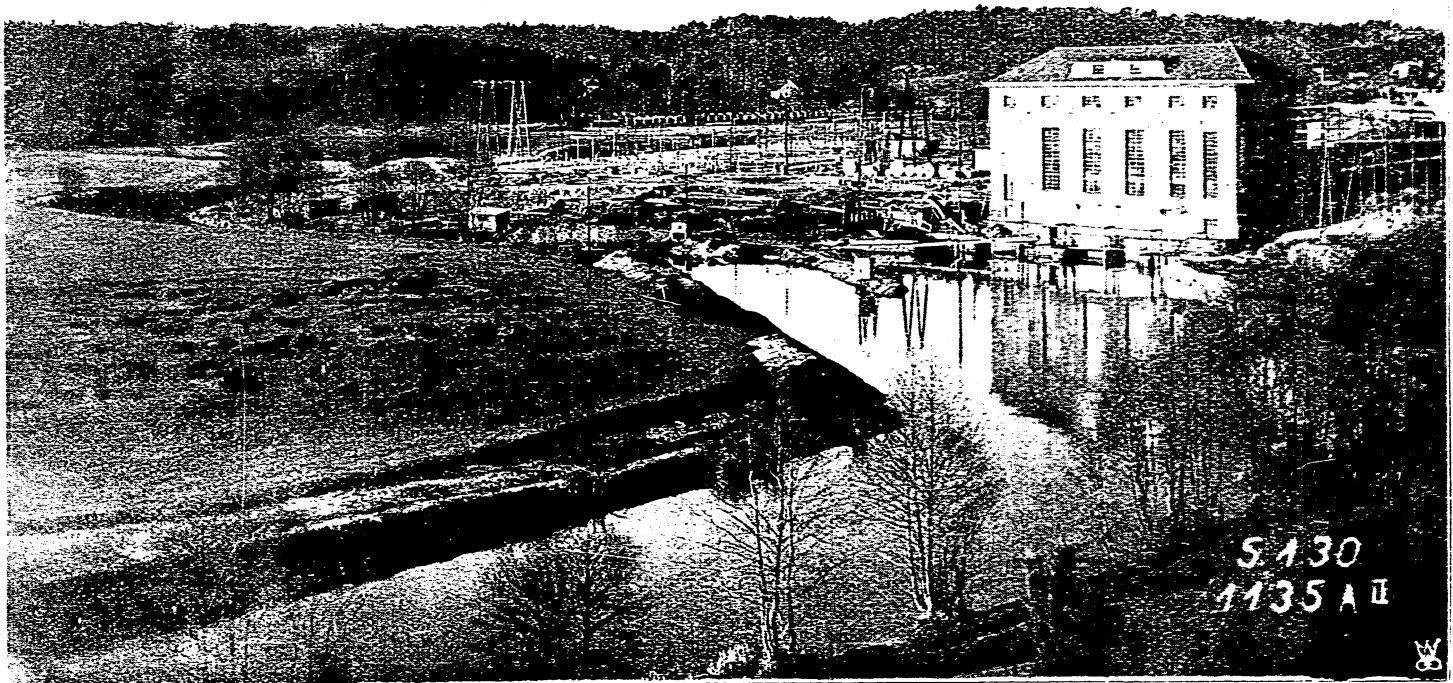


Bridge over the Diversion Canal.



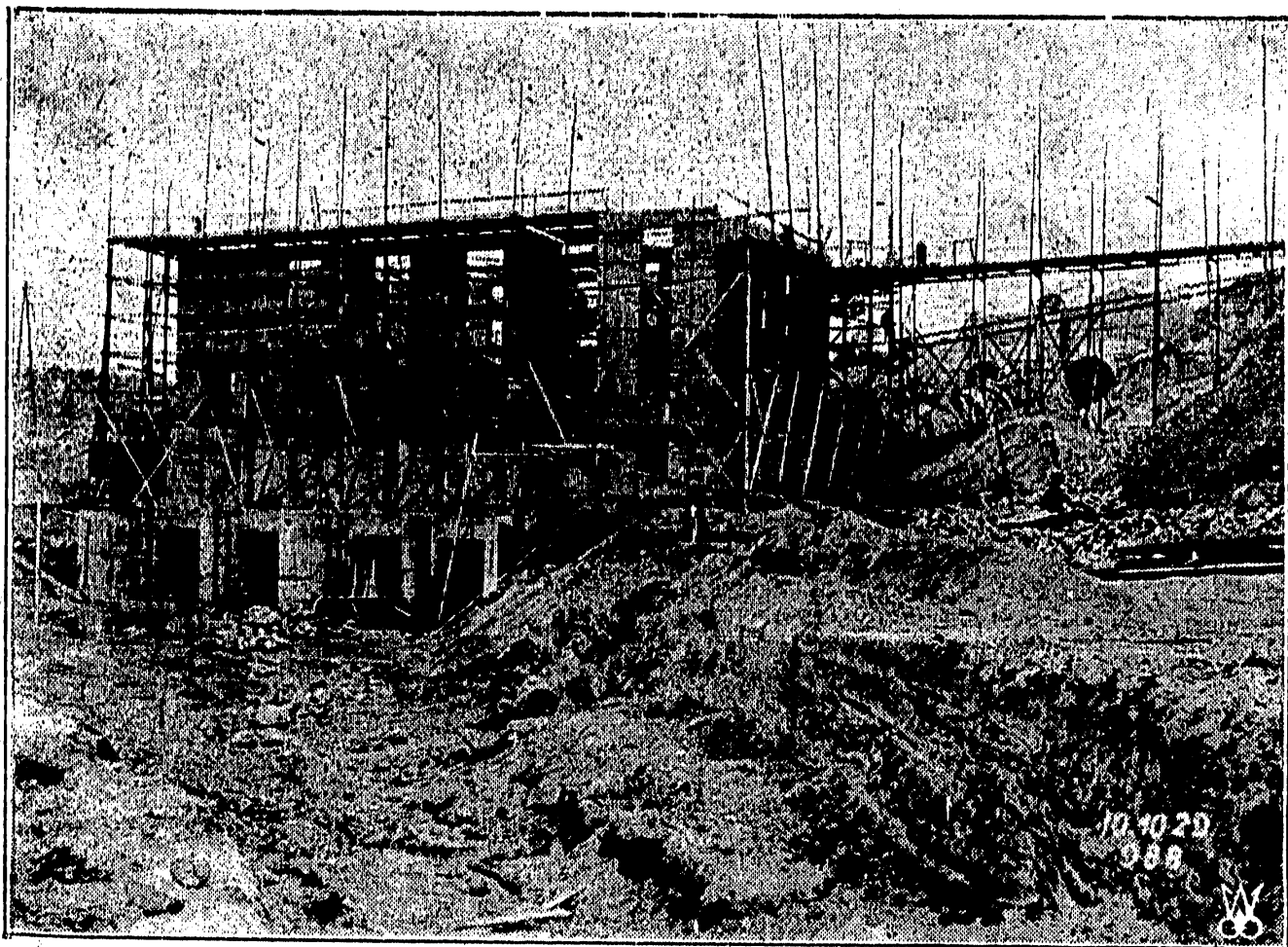
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ZUR DAM, Poland. Plan of the Power Plant. Source: Przegląd Elektrotechniczny, Warsaw, 1931, No.11, p.352

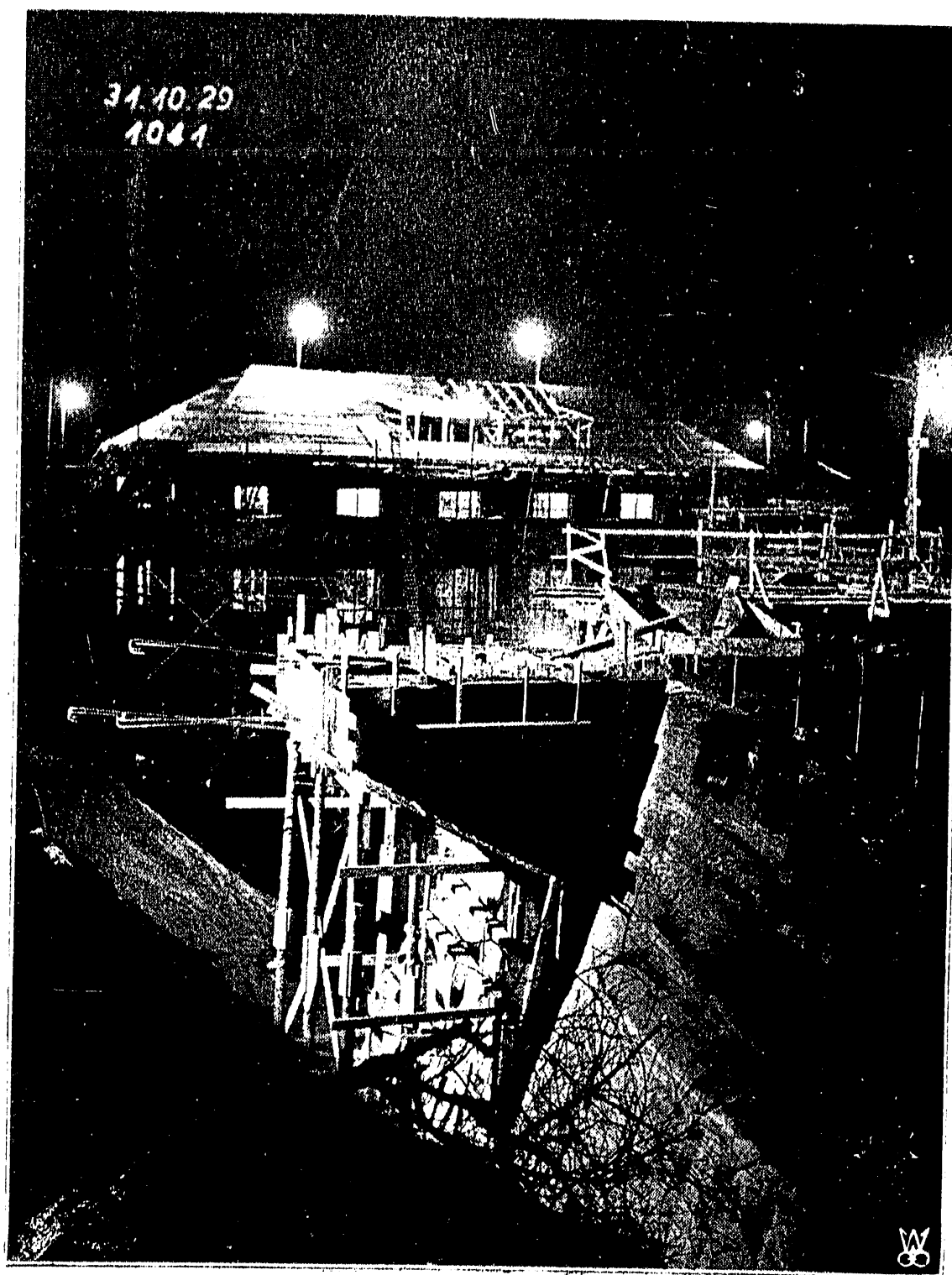


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ZUR DAM, Poland. Powerhouse and Step-up Substation. Source: Przegląd Elektro-
techniczny, Warsaw, 1930, No. 4, p. 83

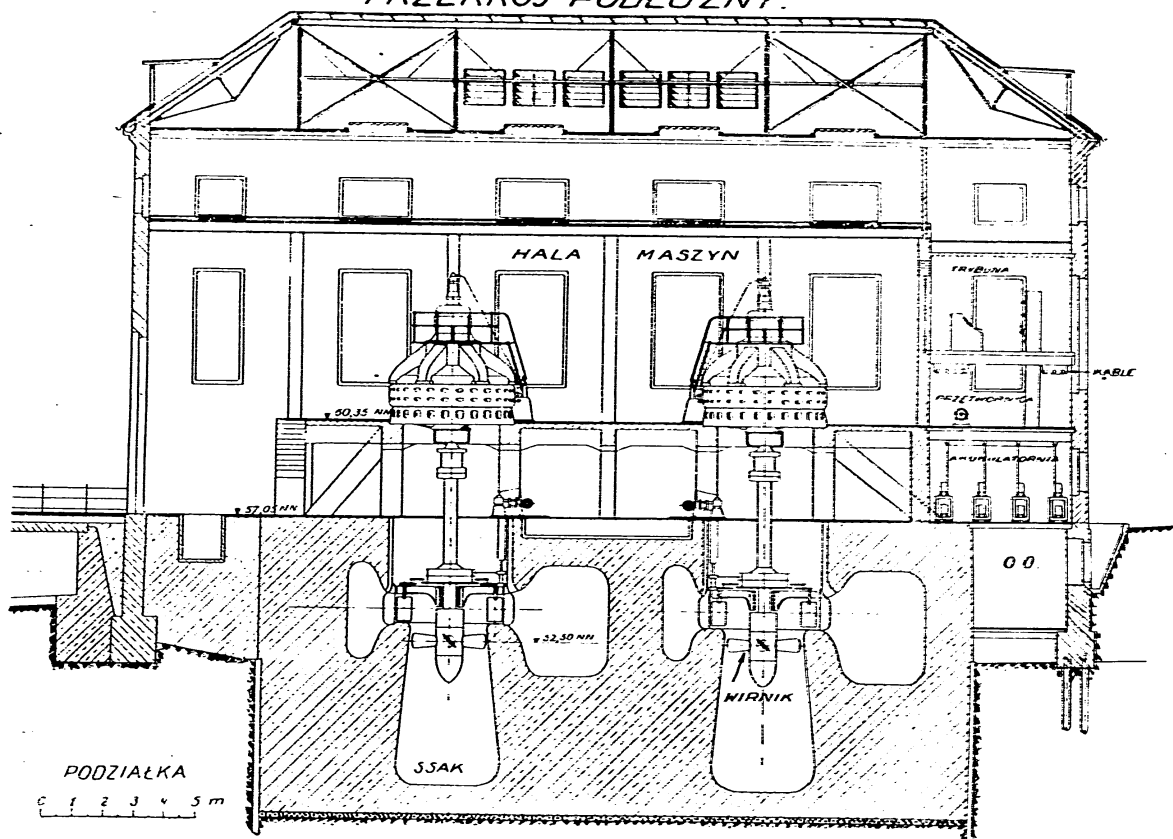


ZUR DAM, Poland. Powerhouse under Construction. Source: Przegląd Elektrotechniczny, Warsaw, 1930, p. 78



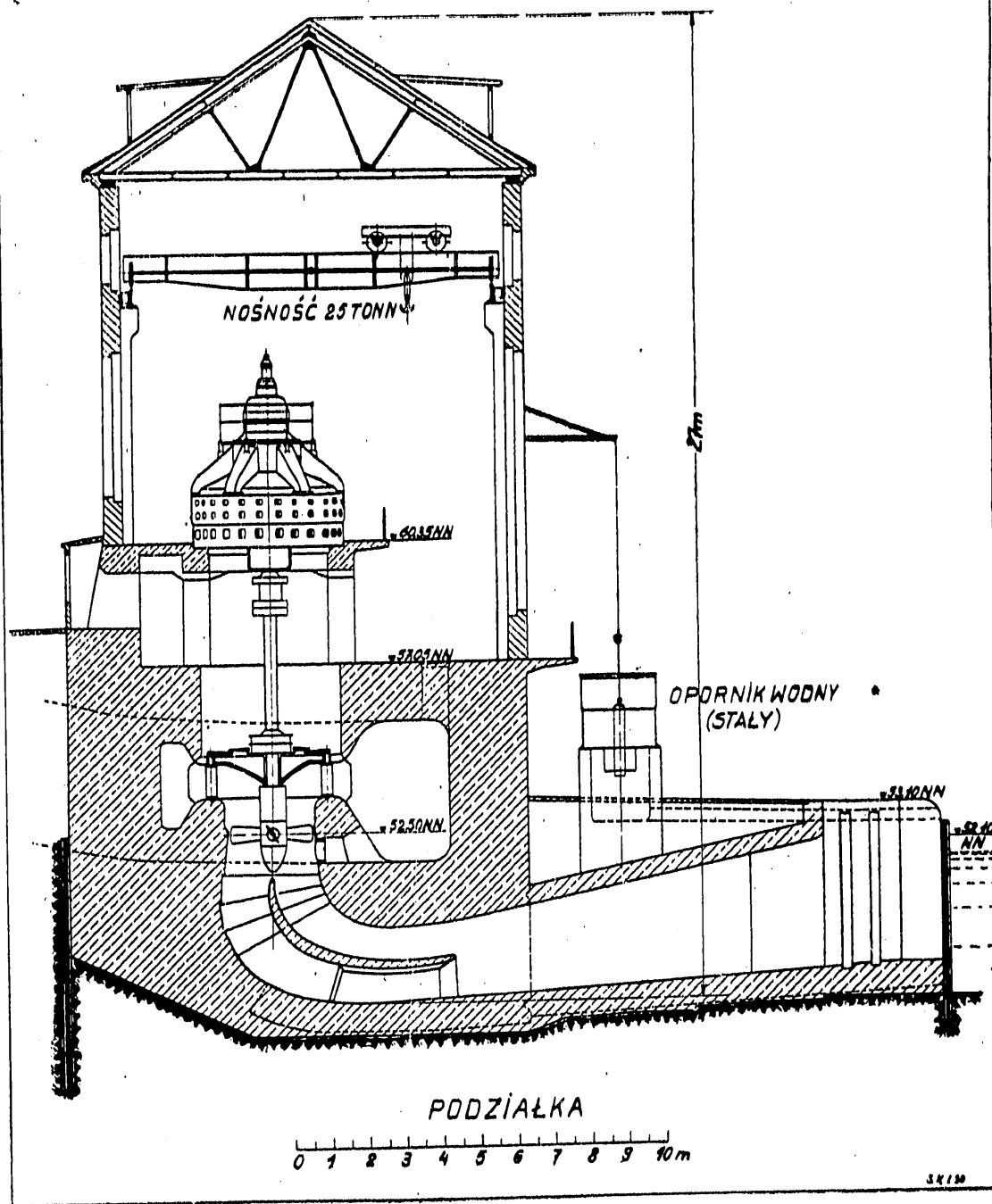
ZUR DAM, Poland. Powerhouse and Gate House under Construction. Source: Przegląd Elektrotechniczny, Warsaw, 1930, p. 78

HALA MASZYN ZAKŁADU W ŻURZE PRZEKRÓJ PODŁUŻNY.

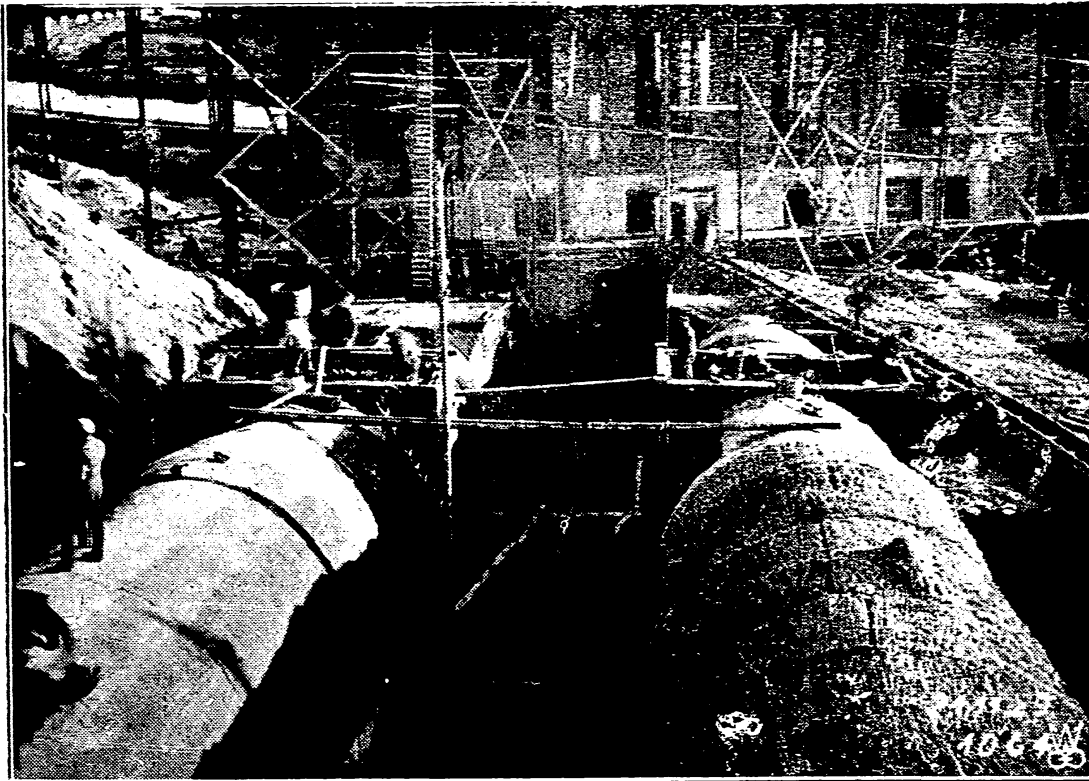


ZUR DAM, Poland. Longitudinal Section of the Powerhouse. Source: Przegląd Elektryczny, Warsaw, 1930, No. 4, p. 84

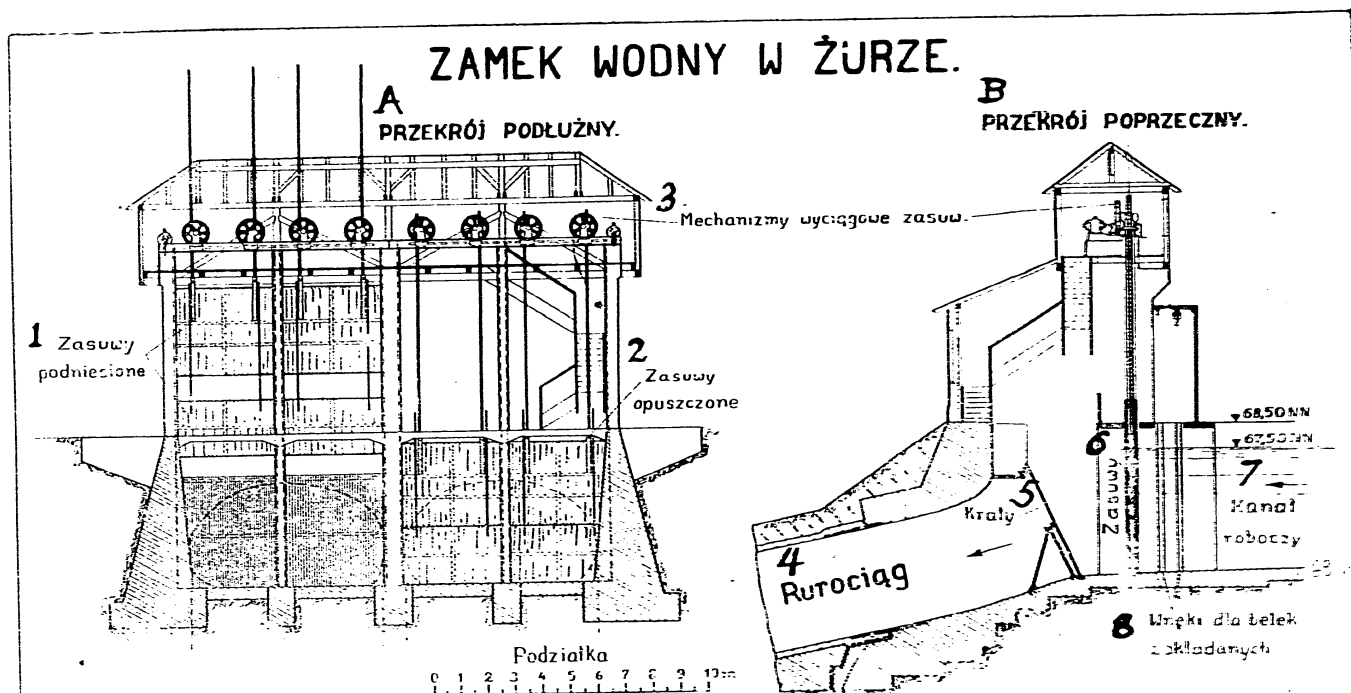
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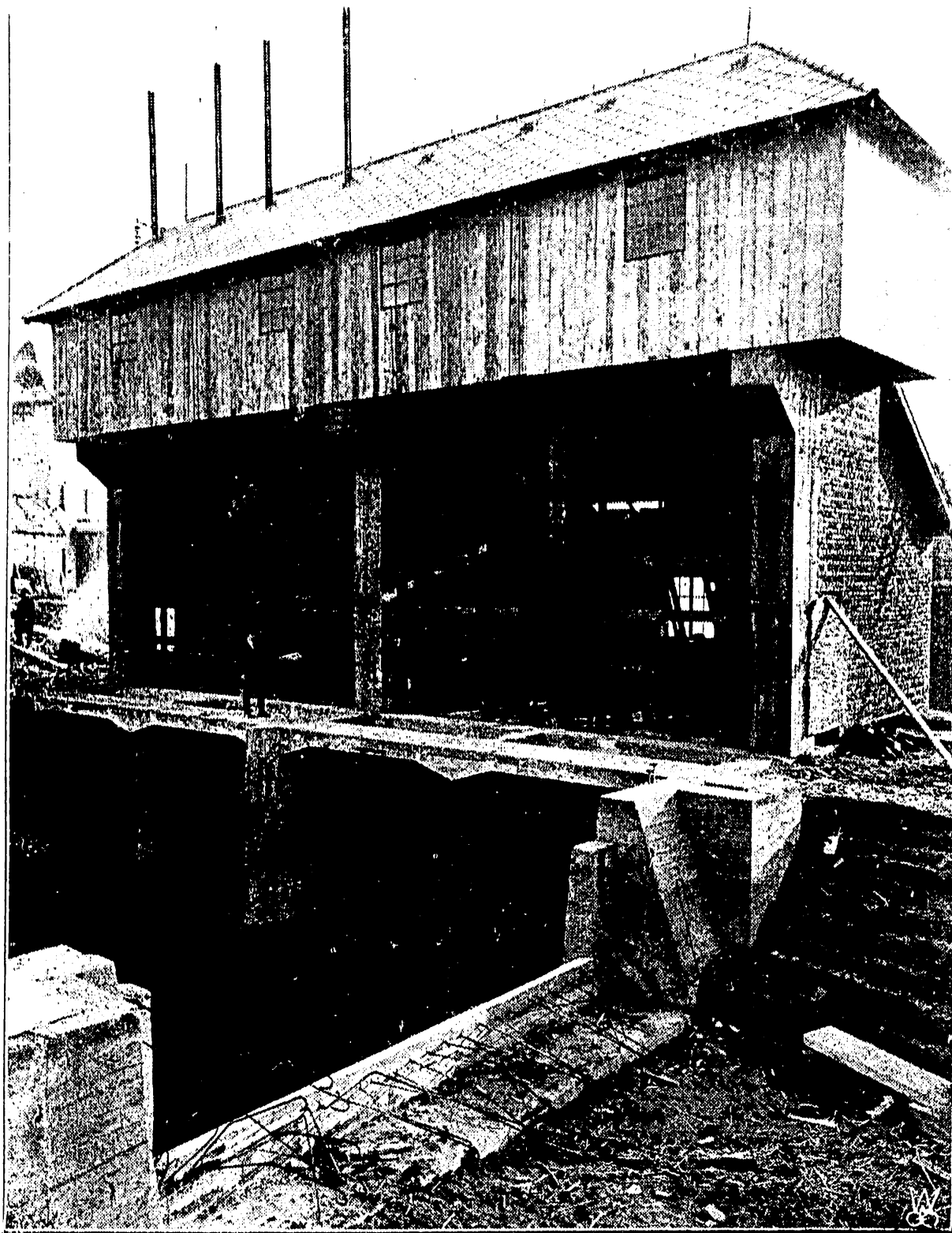
ZUR DAM, Poland. Powerhouse, Cross Section. Source: Przegląd Elektrotechniczny, Warsaw, 1930, No. 4, p. 83



ZUR DAM, Poland. Penstocks. Source:
Przegląd Elektrotechniczny, Warsaw,
1930, No. 4, p. 82



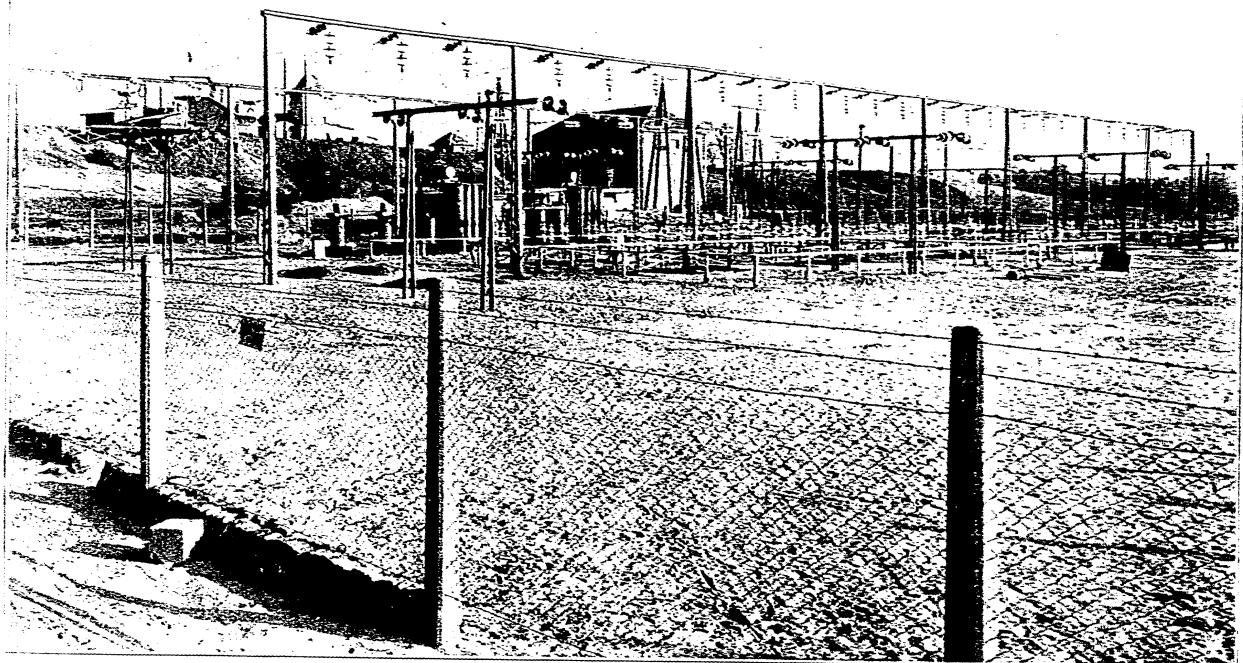
ZUR DAM, Poland. Gate House, A) Longitudinal and B) Cross Sections. 1) Gates opened 2) Gates closed 3) Hoisting mechanisms 4) Penstock 5) Racks 6) Gates 7) Diversion canal 8) Stoplog grooves. Source : Przegląd Elektrotechniczny, Warsaw, 1930, No. 4, p. 81



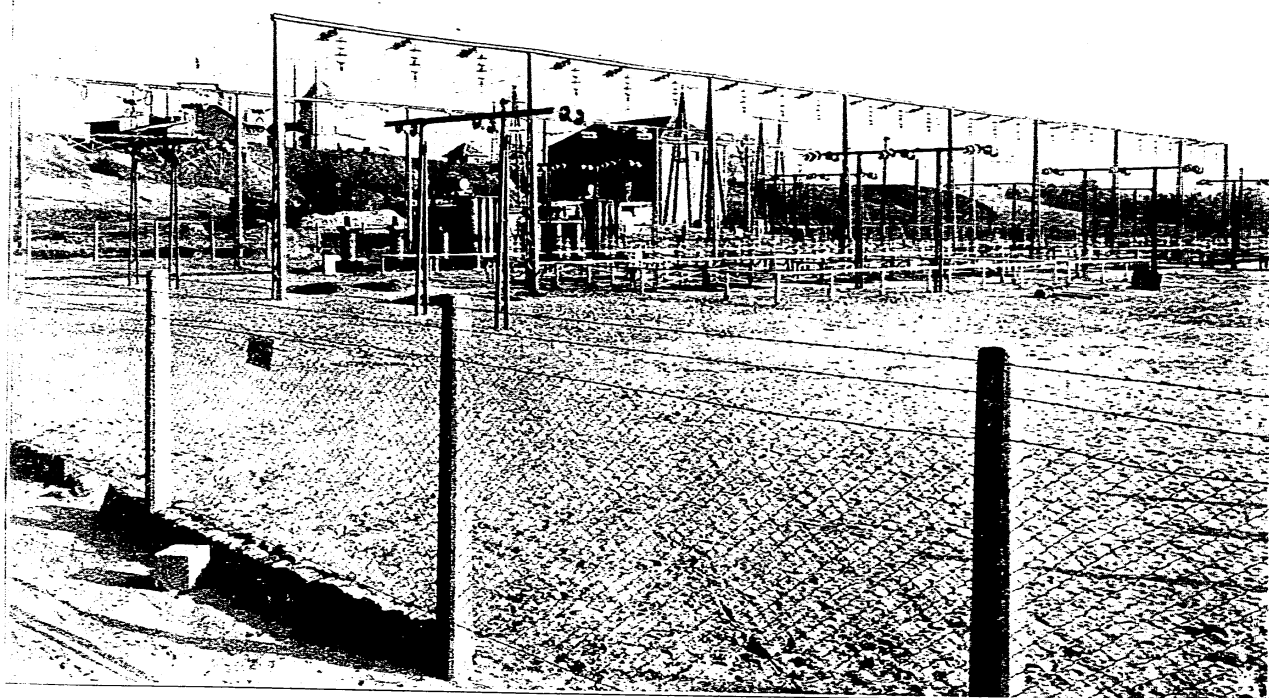
ZUR DAM, Poland. Gate House. Source: Przegląd Elektrotechniczny, Warsaw, 1930, p. 81



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ZUR DAM, Poland. 6/60-kv Transformer Yard. Source: Przegląd Elektrotechniczny, Warsaw, 1930, No. 4, p. 87



ZUR DAM, Poland. 6/60-kv Transformer Yard. Source: Przegląd Elektrotechniczny, Warsaw, 1930, No. 4, p. 87